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Ricardo J. Gómez, *Las Teorías Científicas. Desarrollo - Estructura - Fundamentación.* Tomo I. (Buenos Aires: El Coloquio, 1977), 422 pp., $18.00

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This is the first instalment a two-volume treatise on Scientific Theories, their development, structure and foundation. The present half consists of an introduction, including a long section (pp. 63-156) on "scientific language"—by which the author means the first order predicate calculus—and a First Part, devoted to "formal scientific theories", i.e. mathematics. The discussion of "factual sciences" will appear in the second half. The book can be described as an advanced introduction to contemporary philosophy of science. While on the one hand it raises problems and voices doubts of a sort that is generally avoided in the more elementary textbooks, on the other hand, it demands little or no knowledge of contemporary science and philosophy and deals at length with matters which any moderately sophisticated student would nowadays regard as obvious. In fact one has at times the impression that Professor Gómez is addressing some philosophical Rip van Winkle, who having slept through the 19th and most of the 20th century now wishes to make up for all the intellectual excitment he has missed. (Cf. the detailed proof on pp. 42-53 that scientific statements cannot all be expressed in a language which includes monadic but no polyadic predicates, and that the Aristotelian syllogism is not the only kind of valid deductive inference).

The chief interest of the book will presumably lie in the substantiation of its main philosophical claim, to wit, that

> all empiricism, and all its substitutes—in the first place, logical positivism—are caught in a crisis, where crisis means not just commotion but intellectual bankruptcy (p. 16).

Few will dispute today that logical positivism is intellectually bankrupt—I for one would even add that it never was truly solvent, having lived far too long on I.O.U.'s and on the generous credit of the American academic establishment—but most of us will be curious to learn the author's grounds for extending this verdict to empiricism as such, a philosophical posture which does

not seem easy to beat, unless one unduly restricts the meaning and scope of human experience. He says he will prove his thesis by adopting a logical positivist stance and allowing its intrinsic difficulties to develop from within. However, the present volume does not permit us to judge the success of his enterprise. We must therefore postpone a critical evaluation of it until volume II is made available and give here no more than a sketch of the contents of volume I.

The introduction, besides expounding the syntax and the Tarskian semantics of the first order predicate calculus, criticizes what the author takes to be the presuppositions of the Aristotelian theory of science (i.e. the theory given in the *Posterior Analytics*) and explains Carnap's distinction between formal and factual science and Quine's criticism of it in "Two Dogmas". The First Part aims at "characterizing contemporary mathematics as the paradigm of formal scientific theories" (p. 157). The author takes a Bourbakian view of mathematics, not because he is particularly fond of it, but because it has been so popular with working mathematicians. Bourbaki's achievement is presented as the outcome of a great historical tradition which the author traces back to Euclid. After a brief discussion of the structure of the latter's *Elements*, he explains the historical background and the discovery of non-Euclidean geometry in the standard fashion; a digression on the problem of physical geometry as viewed by Kant, Poincaré and Reichenbach and a Spanish translation of Hilbert's axiom system complete this chapter. It is followed by a neat chapter on Cantor's set theory, transfinite cardinals, Cantor's theorem and the paradoxes, with an instructive comparison of Russell's Theory of Types with Zermelo's Axiomatics. The next chapter, on "Mathematics and Metamathematics" is a remarkably concise and lucid exposition of the development of metalogic and the metatheory of arithmetic in the first half of the 20th century and of the great results attained in the field *entre deux guerres*. Proofs of the completeness and incompleteness theorems of Gödel and of Church's theorem are succintly but accurately sketched and the significance of these results and of the Löwenheim-Skolem theorem is clearly explained. The final chapter contains the author's conclusions regarding the development, structure and foundation of mathematical theories. These can be summarized as follows.

(i) Mathematical theories have developed from the consideration of allegedly intuitive objects, through the discussion of paradoxes, to the formulation of axiom systems; independence proofs (such as Lobachevsky's of Euclid's fifth postulate or Cohen's of Cantor's continuum hypothesis) have finally opened up new, previously unsuspected fields of study.

(ii) Mathematics is the axiomatic study of a hierarchy of mathematical structures: algebras, orders, topologies (a mathematical structure is summarily characterized by Gómez as a list consisting of one or more sets, and one or more properties or relations on them).

(iii) Contemporary mathematical theories cannot be formalized in a nominalistic language (in Goodman's sense) but require quantification over predicate variables; this suggests that the objects of mathematics have their abode in a Platonic realm of essences, but Wittgenstein's "insightful" understanding of mathematics as "a science

> without an object", which handles inkmarks as a chessplayer might handle his wooden pieces, opens the way for an alternative view, which Gómez does not elaborate further but which has all his sympathy.

Though none of these conclusions is remarkably unorthodox they are not beyond discussion. Number (ii) describes well what many mathematicians believe they are doing, but the proven fact that some of the most noteworthy mathematical structures cannot be unambiguously characterized by a computable set of axioms ought to give a philosopher second thoughts. Number (i) is historically true, but in drawing his parallel between the development of geometry and that of set theory Gómez might just as well have mentioned the following important differences:

(a) while alternative systems of geometry can be viewed as dealing with differently structured sets, alternative set theories cannot be thus comfortably housed within some vaster domain. for there is no predicate wider than "is a set" which standard and non-standard set theory could be said to specify in different ways;
(b) while it is difficult to conceive of a development of human thought which would completely do away with the notion of a geometric figure, transfinite cardinals might one day be remembered only as an idle fancy.

Conclusion (iii) seems to be hard to reconcile with the Tarskian semantics which Gómez prescribes for "scientific language"; at any rate. it does not sound very persuasive as it stands, unsupported by argument, unless one happens to share our author's admiration for Wittgenstein's remarks on mathematics. My own, insufficiently grounded but stubbornly persistent impression is that the latter do little more than articulate with a touch of genius the understanding of mathematics achieved by Wittgenstein in his youth, as a reluctant student of engineering.

Before concluding, I wish to emphasize the quality of the present book's reporting on mathematical concepts and results. It is much clearer and more exact than what one ordinarily finds in philosophical books of comparable scope. I have only one complaint: on p. 234 it is said that according to Riemann the line element of a "generalized space" is expressed by the formula given in section II.4 of Riemann's famous lecture of 1854. But that is actually the formula of the line element in a *maximally symmetric* space. The confusion would not be worth mentioning but for the fact that Riemann's pioneering conception of space was rejected by many 19th century mathematicians and philosophers (e.g. by Bertrand Russell in his book of 1897), who, taking their cue from Helmholtz, maintained that a space worthy of that name must be maximally symmetric, i.e.. must be transitively acted upon by its group of motions, a condition which Riemannian spaces do not generally meet.